



Course Brief and Outline—2006

Course Co-ordinator:

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1 Course Background and Purpose

The aim of the course is to provide an overview of electromagnetic concepts and to lay a sound theoretical foundation. It therefore includes the debunking of the standard “black magic” image of electromagnetics, where problems are solved by “thumb suck” and side-cutters!

Electromagnetics pervades almost every aspect of our everyday lives, Radio, TV, Ordinary Telephones, Cell’s Doll, Microwave Ovens, Radar, Remote Sensing, Medical Electronics, Roving Mars Robots, Iridium/GlobalStar Satellite “phones”, GPS positioning, Wireless LANs at Ethernet speeds, “toy” LANs like Bluetooth, broadband microwave LANs. . .

In many ways, Electromagnetics can be viewed as a superset of circuit theory, with the power flow through the mysterious “ether” as opposed to a physical circuit. Thus the student is exposed to a broader and more general context than before.

There is a growing awareness of compatibility issues in Electromagnetics—what with planes crashing by Notebook; cancer by 50Hz; Brain tumors by Cellular phone—so it is essential that *knowledge* of this field is gained by *all* engineers, so that the effect on the environment is minimized (and to improve the SNR :-).

It is to be remembered that the Electromagnetic Spectrum is simply another part of our environment, but that its pollution and desecration is just not so easily seen!

2 Course Outcomes

On successful completion of this course, the student is capable of:

1. understanding electromagnetics terminology;
2. using simple finite element software;
3. using sophisticated Method-of-Moments software;
4. designing simple transmission line systems, including matching circuits;
5. antenna and radiation fundamentals; and
6. understanding electromagnetic compatibility issues.

3 Course Content

Transmission Lines Introduction, infinite transmission line, terminated transmission line, input impedance, standing and travelling waves, VSWR, power flow

Smith Chart Development, use, matching—single and double stub. Scattering parameters

Static Fields Basic revision of electric fields, flux, duality, field plotting

Maxwell's Equations For plane waves; boundary conditions—conductors and dielectrics; Depth of penetration (skin depth)

Antennas Basic radiation fundamentals, launching and receiving radiating waves.

Applications EMC, Shielding effectiveness, remote sensing, waveguides

4 Prior Knowledge Assumed

Thorough knowledge of basic physics, especially the field components, and a thorough grasp of mathematics, especially vector calculus.

5 Assessment

5.1 Components of the Assessment

The final mark for Electromagnetics is made up as follows:

Test:	30%
Labs:	10%
Final Exam:	60%

5.2 Assessment Criteria

The student's understanding of the fundamental aspects of the course will be probed. Exam questions etc will need to be answered in order to answer the question: "WHY?" as opposed to the simplistic "HOW". I am not attempting to assess a simple methodology, I will assess fundamental understanding of concepts.

Note that the onus is upon the student to convey this understanding in an examination. A terse, correct "answer" may not necessarily attract marks! Please refer to my exam writing skills notes at ytdp.ee.wits.ac.za/ExamWritingSkills.html.

5.3 Calculators in Examinations

The examination will be of 3 hours duration and will cover *all* material covered in the course. It will be a closed book exam, allowing a type 2 calculator (ie an engineering calculator) and an A4 *handwritten* information sheet. The standard statement on these sheets follows:

An A4 information sheet may be brought into the examination. Both sides of the sheet may be used for text, figures and equations, but it must be hand-written. No printed or photostatic copies are allowed. No additional reading aids are allowed.

Obviously, the test is under similar jurisdiction.

6 Teaching and Learning Process

6.1 Teaching and Learning Approach

My lecturing style is highly interactive, and largely of the “chalk and talk” variety. This means that the emphasis during lectures is upon understanding, and not on “transferring the lecturer’s notes to those of the student, without passing through the minds of either”. Interaction on the part of the student is required.

One negative consequence of an interactive lecturing style (as opposed to a transfer of notes style), is that the student actually gains *an* understanding in the lecture. If it assumed that this *initial* understanding is all that is required, disaster occurs. Learning is an *iterative* exercise, and requires constant re-inforcement. My lecturing style can thus lead to a complacency which is rudely interrupted at examination time. HENCE:

Tutorial exercises are designed to complement and probe material currently being taught. They are not necessarily designed as examination questions. Doing these exercises only just before the exams will not help. They are to be done concurrently with the material being explored.

6.2 Arrangements

Lectures:

There will be three lectures per week, on a **double on Tuesday at 08h00, and a single on Wednesday at 10h15**

Tutorials:

There will also be a tutorial on **Wednesday at 11h15**.

Laboratories

There will be 2 laboratories associated with this course held in the Basic Laboratory, covering topics taught in the course, as well as topics not formally dealt with in lectures.

Students who have not done the lab preparations will be asked to leave the laboratory.

Students are required to attend all labs; failure to do so will result in a Satisfactory Performance refusal.

7 Information to Support the Course

7.1 Prescribed Text/Reading

No text perfectly covers the course material: all books have flaws. If it can be obtained the *Third Edition* of “Electromagnetics” by J.D. Kraus (McGraw-Hill) is definitive. The *Fourth Edition* is OK, the *Fifth Edition*, co-authored by Fleisch, is completely useless.

- Cheng, D.K (1989) “Field and Wave Electromagnetics” Second Edition, Addison Welsey Publishers.

In addition, as of 2004, there is a “Study Guide” provided by Poynting Innovations below cost:

- Clark A. R. (2004) “SUPERNEC Study Guide for Electromagnetics and Antennas”, Poynting Innovations.

7.2 Course Home Page

For other information related to the course, please refer to the Course Home page at <http://ytdp.ee.wits.ac.za/elen302Home.html>

8 Other Information

Although the University Senate has ruled that attendance at lectures is not compulsory, lectures will be used to *supplement* course texts, and this supplementary information *will* be examinable. Announcements relating to the course will also be made in lectures from time to time.

I have what I call a “Modified Open Door” policy. You can come and see me at any time, but only in groups! I have a great regard for the peer-support system; you only really understand something if you can explain it to your peers. I have long ago forgotten the particular difficulties I had with some of the concepts taught in this course, they now appear to me as “obvious”; peers do not have this myopia.

The preferred method of contact, however, is email.

The Third Year notice board may be used for any course announcements.

The online version is <http://ytdp.ee.wits.ac.za/elen302outline.html>